New Housing Models for an Autarkic Rural Community

Burford, Neil; Robertson, Carol

Published in:
Architecture_MPS

Publication date:
2015

Document Version
Peer reviewed version

Housing - Critical Futures. UK Conference. 08-09 April 2015

NEW HOUSING MODELS FOR AN AUTARKIC RURAL COMMUNITY

DR NEIL BURFORD
ARCHITECTURE AND PLANNING, SCHOOL OF THE ENVIRONMENT, UNIVERSITY OF DUNDEE

CAROL ROBERTSON
ARCHITECTURE AND PLANNING, SCHOOL OF THE ENVIRONMENT, UNIVERSITY OF DUNDEE

Abstract

Autarky, the quality of being self-sufficient, potentially provides a new sustainable, economic model for rural living that could reverse recent high-carbon settlement practices and the associated costs of rural home ownership. This paper explores new spatial forms of autarkic housing for a rural site owned by the National Trust for Scotland in Cottown, Perthshire where the demand for new housing in near rural areas is predicted to increase by as much as 33%. The Grade-A listed thatched and earth-walled Schoolhouse, a relic from a lost local vernacular once widespread throughout the Carse of Gowrie, acted as a catalyst for sustainable thinking along with a body of thematic research into national, regional and local trends in population, housing demand and energy consumption. The research directed proposals for alternative theoretical models and spatial concepts for affordable, low-energy regionally responsive housing development. The study uses map progression and measured survey work analysing the layout and building characteristics of the hamlet. While density studies identified the current capacity of the developer model, setting the benchmark for financial viability, proposals are based on urban densities whilst maintaining overall numbers of units with the objective of intensifying the reading of landscape between built form and open space, and releasing land for community use, food and energy production. Intended as an alternative to mass-market housing, the proposals address the broader requirements of the Scottish context in terms of sustainability, low energy use, low-carbon material resources, and the competitive market place. The spatial quality of the proposals at intimate and distant scales are key considerations in developing imaginative and appropriate solutions for new forms of sustainable living, with forms and an identity directly related to the site's particular geographical location and peculiar regional sustainable building traditions.

Introduction

“The country can steadily be regarded as a city state...filled with this low density, light weight urban matter lacking a clear form of organisation, consisting as it does of development that has to be varied all over and, perhaps as a result, ends up looking the same. This urbanity is more concerned with quantity than quality” (Koek, Maas & Van Rijs,1998).

This observation by Koek, Maas and Rijs on urban planning and density highlights the problematic relationship between population, density and sustainability in the planning of cities and their regions in the Netherlands. In FARMAX: Excursions on Density in 1998, they proposed new models and forms of urban development based on Floor Area Ratio (FAR): the maximisation of the ratio of gross floor area of a building to the total size of its plot thereby unlocking a site’s potential through releasing plot area for other economic, social or sustainability enterprises. These new models relied on increased density, concentrated land use with mixed economics and in some cases new hybrid-typologies of urban and agricultural zoning. The proposals were a reaction to the limitations of the Fourth Spatial Policy Plan Extra (Vinex, 1991) (Cousins, 2009). Although being an implicit strategy towards sustainable urban development through a policy of ‘concentrated de-concentration’, the Vinex Policy had failed to deliver higher quality housing and sustainable, economic communities leading to widespread mono-cultural suburban sprawl and the pressurization on valuable agricultural land (Goedman et al., 2008). Similar patterns of speculative development which are driven by mass-market considerations and led by commercial sector developers and volume house builders are in evidence worldwide. In the UK it is particularly prevalent and while legislation is beginning to adapt in recognition of the deficiencies of this approach, much of this focuses on urban contexts while the rural environment receives less attention. And yet arguably the rural environment is an intrinsic component in the establishment of an integrated economic and sustainability framework that is needed to achieve low carbon regions, as first proposed by urban planner and sociologist Patrick Geddes in The Regional Plan in 1909 (Mellor 1990).

The driver behind the need for ‘sustainable’ development is to mitigate the impact that predicted climate change will have on our cities, land uses and infrastructural systems. Additionally, as people’s requirements change, throughout their lives and from one generation to the next, developments that can accommodate individual, collective and cultural diversity without undue impact on the environment will be richer places to live. Currently, more robust planning legislation governing the quality of our built environments and more onerous energy efficiency standards are making incremental improvements to new and existing building stock and the planning of communities. However, a step-change needs to be made in the conceptualisation, zoning, planning and deployment of future communities and housing to fully integrate buildings and people within a regional low-carbon strategy. Such strategies need to accommodate new forms and typologies of living that are more biological in nature in their ability to absorb such diverse requirements as mixed and hybrid-land and building uses, adaptable housing layouts, alternative live-work practices, varied tenures, self-sufficiency in food production, district heat networks and sustainable power generation. This raises further questions as to the effectiveness of national and local planning policies and how these are interpreted and applied in practice and whether these policies in their current form have the capability to deliver the equitable and sustainable low-carbon neighbourhoods and communities that we need to take us through the 21st century.

One concept that has emerged recently in central Europe that begins to bring these ideas and issues into focus is that of autarky, or the ability for a community to be self-sufficient in their resources and needs. Its roots are in the energy crisis of 1972, and the emerging thinking that followed. The seminal works of the Vales through the building of the Southwell House (1995), a prototype for future sustainable housing, was designed to be net autonomous in heating and power energy demand, water supply and waste treatment, effectively the UK’s first sustainable off-grid building (Burford and Pearson 2013). The principles were covered in detail in the book The New Autonomous House (Vale & Vale 2000). In 1998, the Vales developed this concept for a group of five grid-connected, earth-sheltered, ultra-low-energy terraced houses at Hockerton, Nottinghamshire, an energy self-sufficient

development powered from two wind turbines and a solar PV system resulting in very-low total energy requirement. From around the same period, the Vauban district of Freiburg has emerged as a model for sustainable living, exemplifying the integration of renewable energy design from the level of public policy and urban planning to the details of architectural form and technologies (Guzowski 2010). More recently the Voralberg Region of Austria is applying these concepts through legislation at a regional level (Zammer 2005). The following paper explores these issues by examining a conceptual project for a proposed new autarkic rural community at Cottown in the Carse of Gowrie, Perthshire. It proposes a number of new typological models and alternative sustainable spatial arrangements for low-energy rural housing that respond to higher density planning, hybrid land-use, innovative housing models, renewable energy provision and new formal regional languages.

Sustainable Place-Making Legislation in Scotland

In June 2014 the Scottish Government published its National Policy Framework 3 (NPF 3)(2014a) and Scottish Planning Policy (SPP)(2014b) documents which set out the spatial development priorities and the policies to deliver them over the next 20 – 30 years. The outcomes are designed to deliver a "more successful country, with opportunities for all of Scotland to flourish, through increasing sustainable economic growth" (Scottish Government, 2014a). The development outcomes to help realise this ambition, are stated as being the following:

- A successful, sustainable place
- A low Carbon Place
- A natural, resilient place
- A more connected place

In all of the above outcomes 'place' is the key recurring development theme. Good quality places, in their widest sense, are the foundation to our well-being on both a societal and individual level. A holistic approach that acknowledges and balances these key components within distinctive locations is the cornerstone of current government policy. Place-making, whether completely new environments, or the regeneration of existing ones, is seen as the social and capital investment that we need to make to ensure our long term prosperity. The legislative framework that has been evolving over the past decade has sought to identify the components of good place-making and through policy documents such as Designing Places (Scottish Government, 2001) and more recently Designing Streets (Scottish Government, 2010a) and the Scottish Planning Policy (Scottish Government 2014b) define these as material considerations in the determination of development proposals. Within the policy document Creating Places, 'place' is considered to comprise the following: "The environment in which we live; the people that inhabit these spaces; and the quality of life that comes from the interaction of people and their surroundings" (Scottish Government, 2013, p.10). The legislative criteria on which the success of a place is judged has been reduced to six key components backed up by a body of research and case study material dating from 1999 (Gulliver and Tolson undated). At this point in time Scottish planning legislation defines successful places to be the sum of the following parts: Distinctive, Safe and Pleasant, Welcoming, Easy to Move Around, Adaptable, and Resource Efficient (Scottish Government 2014b, p.13-14). Although the SPP and NPF3 policy documents referred to were only published this year the embodied goals and intents have been established for a number of years. Designing Places was published by the Scottish Government in 2001 yet, except for a few notable examples, there is little evidence in the delivery of the types of places the legislation is aspiring to on the ground. As the Scottish Government's Council of Economic Advisers commented in 2008, "Too much development in Scotland is a missed opportunity and of mediocre or indifferent quality" (Gulliver and Tolson, undated). We need to improve what is actually built across Scotland. As a goal our planning framework should deliver environments where the initial site analysis will "blend topography, temperature, wind and solar radiation with street pattern, scale, massing and landmarks." (Thomas and Garnham, 2007).

Towards Energy Autarkic Communities

One of the major drivers for change in the built environment is the Scottish and UK Government's commitment to reducing carbon emissions. Over the last 10 years, the European Union has developed world recognised carbon abatement policies leading with the Zero Carbon Roadmap 2050 which envisions strategies and policy implementation at national and regional levels for a de-carbonised

power sector by 2050 (ROADMAP 2050, 2015) (Figure 1). This is seen as being intrinsic to reducing greenhouse gas emissions, securing supply, and driving sustainable economic development. The policy has a number of key strands which directly impact on new and existing development including: increased building energy efficiency measures, creating cost savings and reducing demand; investments in regional grid inter-connection, minimizing back-up supply and load-balancing requirements and laying the foundation for rapid fuel switch to electricity in buildings and transport sectors. The Energy Performance of Buildings Directive (2002/91/EC) develops broad policy requirements for lowering the carbon footprint of new and existing building stock through the use of improved technical specification and building regulations which feeds into national building standards. Energy and greenhouse gas (GHG) emission policies are defined in Scotland in the Climate Change (Scotland) Act 2009 which sets a target of an 80% reduction by 2050 with an interim target of 42% by 2020. This is manifested in the Building (Scotland) Act 2003 which quantifies these measures, the Platinum Standard being Zero Carbon (detail to be defined). Other agencies are tasked with implementing and writing policies that seek to improve infrastructure, environment, transport and well-being, all significant components of 'sustainable' development.

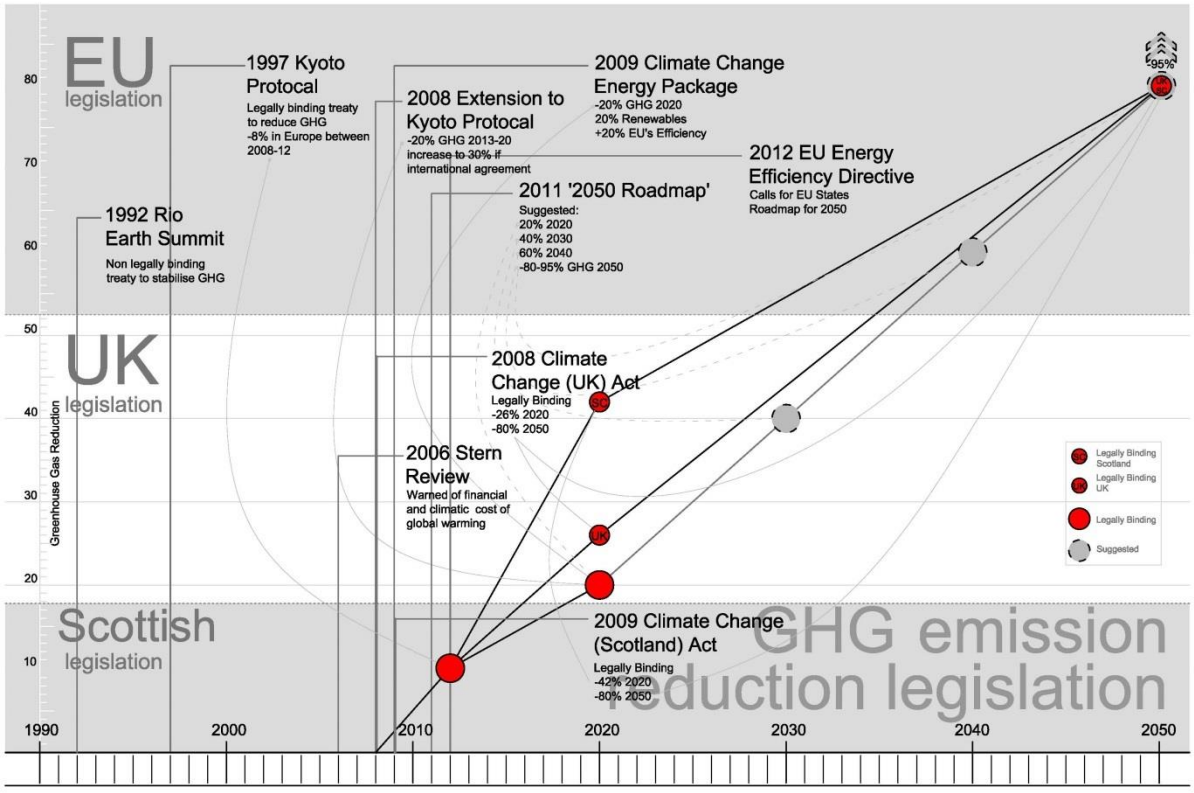

Figure 1: European Union and UK Energy context and legislation (Adapted from Pearson 2014)

Improvements in energy performance are enforced through the Building Standards Technical Handbook (Scottish Government 2013c), However, material and technical design considerations – those where a building is designed to be constructed, and ultimately dismantled, with minimum waste coupled with reduced energy input to maintain its internal environments - is only one aspect of resource efficiency. Resource efficiency is also required in the servicing infrastructure for any development and this needs to be incorporated within the planning legislation in order to apply this strategically. By sharing resources and looking at the issues to be tackled as holistically as possible the capital costs of infrastructure works can be reduced and the energy efficiency of the buildings that plug into that infrastructure can be improved. Along with infrastructure, building fabric and building services, the micro climate of a development will influence the energy efficiency of its component buildings. Therefore, it is very important that a development strategy takes cognisance of the prevailing winds and solar paths. Site planning and solar optimisation are currently absent from both planning and building standards legislation; in the former the requirements are too vague and in the latter average UK climate data is used in the Standard Assessment Procedure (SAP) to quantify energy

performance but this acts against a strategy for regional and site responsive design which is in opposition to sustainable place making (Burford & Pearson 2013) (Figure 2). Similarly, it is clear from European legislation that de-carbonised energy sources and, in particular, renewable power generation and storage are at the centre of EU policies but this has still to be recognized adequately as an intrinsic component in both the UK planning policy for new developments or in Building Standards requirements.

Figure 2: Typical mass-market house typology and suburban layout pattern, Meigle, Perthshire.

Not having to depend on energy imports is a vision that has emerged recently and is gaining popularity in central Europe. Energy self-sufficiency or energy autarky is the ability to meet energy demand through regional renewable sources of energy, saving energy, and using energy more efficiently (Abeg 2011). It is a strategy for dealing with both climate change and energy security to the benefit of the regional economy, society, and environment. Energy autarky can thus be described as a location that relies on its own energy resources for generating the useful energy required to sustain the society within that region or a situation in which a region does not import substantial amounts of energy resources (Owens et al, 2014). The concept can be applied at individual building, community and regional scales and employs technical solutions to optimise energy generation, energy storage and control technologies to achieve self-sufficiency. As such it can be used to strategize planning based on renewable energy generation and low-carbon resource availability at regional levels, and in determining the location, scale and nature of new development based on the sustainable and economic use of local and regional low-carbon energy sources. Functioning autarkic energy systems typically require a micro-grid, defined energy demand and supply characteristics, opportunities for energy

storage and controls able to manage the harmonization of system components (Owens et al., 2014). A number of European regions are developing strategies for energy autarky including Güssing, Austria, the Jühnde, Germany, Samsø, Denmark and the Island of Eigg in Scotland. These pioneer areas are leading the way, not merely to eliminate energy imports, but also to use energy economically and efficiently, meet their own demand as far as possible with renewable energies, and at the same time stimulate the regional economy (Abeg 2011). Often, the objective of becoming a carbon-neutral region is closely linked with this economic goal as revenue from net energy export can be used to re-invest in social infrastructure, growth of local sustainable enterprise, investment in affordable housing with reduced energy requirements and improved agricultural production. Sustainable low or zero-carbon energy can be the economic catalyst for practically delivering autarkic sustainable communities in the broadest sense. This may well be one solution to developing robust regional rural economies, viable affordable rural housing and sustainable rural living practices in Scotland.

Perthshire Housing Requirements and Rural Migration

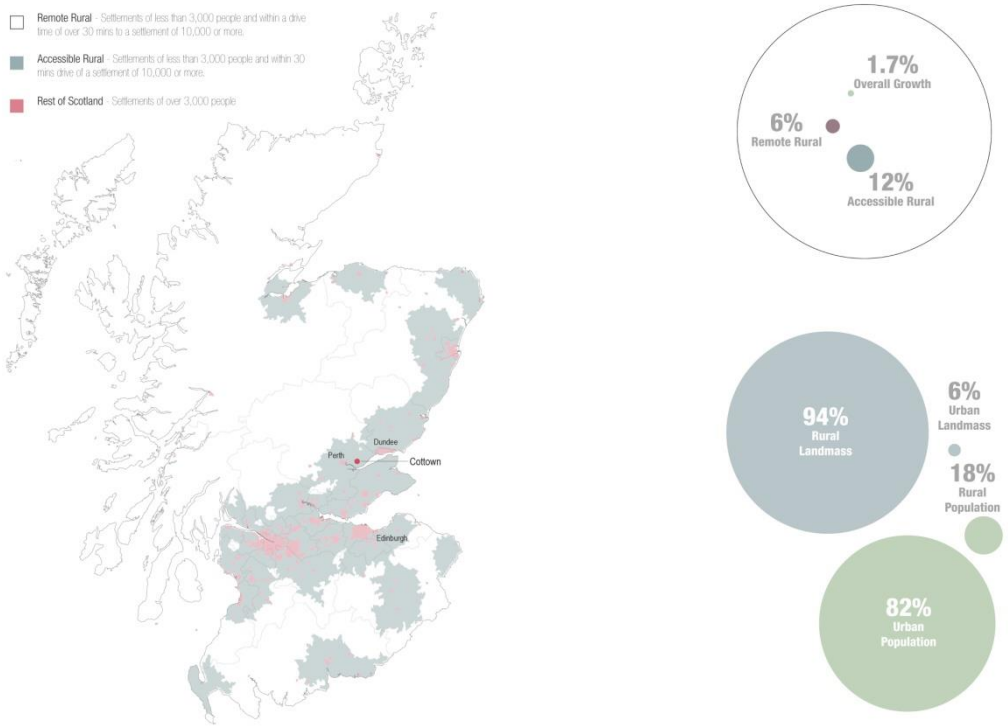

Figure 3 Rural Classification, and Relationship between Population and Land Mass

The provision of housing is key in the creation of sustainable low carbon communities through the development of alternative spatial and technical concepts appropriate to their environment. Scotland's population is projected to increase from 5.2 million in 2013 to 5.5 million in 2033, with the effects of inward migration and changes in household structures influencing a predicted 22% increase in the number of households (GROS, 2010a, p3). Around 94% of rural Scotland accommodates only 20% of the population and house prices are increasing more rapidly in rural than urban areas (Scottish Government, 2012, p3). The population in Accessible Rural areas, the definition being settlements of less than 3,000 people and within 30mins drive of a settlement of 10,000 or more, has recently increased by 12% (Scottish Government, 2012, p5, p7) (Figure 3). Classed as Accessible Rural, the Perth & Kinross region is expected to encounter the largest increase in population across the 32 council areas of Scotland at 27%, and a 37% increase in the number of households, with significant implications for housing demand (GROS, 2010a, p1; GROS, 2010b, p1). The problem is compounded by the relationship between higher than average property prices and lower than average annual salaries in Perth & Kinross when compared to national statistics, illustrated by the 22% decrease in real value earnings in the region (GMB, 2013) (Figure 4). Finding the capital to buy available property is being affected by the rise in the average deposit from 10% to 21% between 2001- 2011, which has influenced the 56% fall in the number of first time buyers in Scotland (Perth & Kinross Council, 2012). Young buyers in the 16-34 age group, a demographic predicted to increase by 19% in Perth & Kinross, will find it increasingly difficult to build up the required funds (Perth & Kinross Council, 2012).

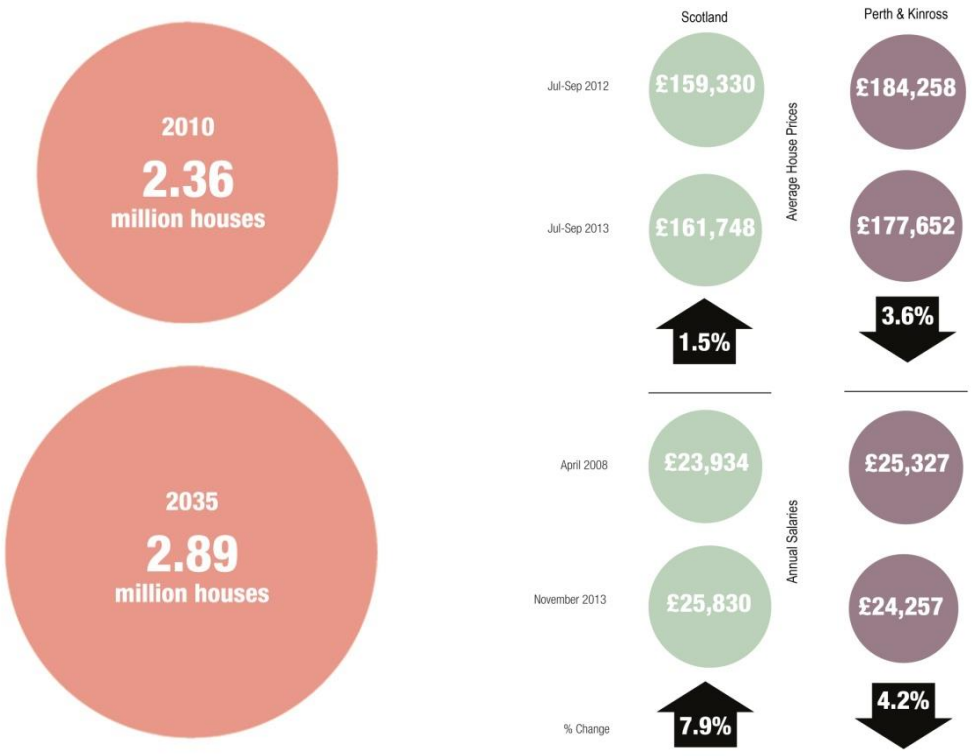

Figure 4. Housing Demand and Comparison of Average House Prices and Annual Salaries

TAYPlan, the Strategic Development Plan delivered in partnership by Fife, Dundee, Angus and Perth & Kinross Councils, proposes major expansion of the cities of Perth and Dundee between 2012-2032. Main principles include "Supporting sustainable economic development and improving regional image and distinctiveness; Enhancing the quality of place through better development outcomes", with objectives including the provision of good quality housing of mixed type, size and tenure through effective supply of land, the promotion of rural economic development, and the support and provision of renewable energy and low carbon technologies (TAYPlan, 2012). A significant proportion of the

future housing allocation is in the Carse of Gowrie, an area of low lying agricultural land, small towns and hamlets sitting along the banks of the River Tay between Dundee and Perth.

Local Sustainable Vernacular Traditions of the Carse of Gowrie

The Carse of Gowrie has a long history of being self-sustaining through thriving agriculture, renowned orchards and locally sourced materials, its southern aspect and low rainfall offering ideal growing conditions making it prime high value agricultural land. The area falls within the Perth & Kinross Council Local Development Plan which identifies potential development sites for the provision of housing and employment through expansion of existing settlements to strengthen infrastructure and networks. Development sites have been identified which reinforce the ribbon development which forms the village of Cottown, a small collection of houses distributed along two minor roads approximately 8 miles to the east of Perth. The larger of the development sites, at approximately 0.9 hectares, is located to the north west of the village, with existing houses to the east and agricultural land typical of the area to the west. Orchards were first planted in the area by Cistercian monks in the 12th century with production from over 50 commercial orchards reaching its peak in the early 19th century. Fruit growing has declined during recent times due to cheaper imports from abroad, and remaining orchards, although of high biodiversity value, are in poor condition. Many have been lost due to clearance for agriculture, neglect and housing development (Hayes, 2011). There is a particularly high concentration of surviving mud wall structures in the area due to the drier climate on the east of Scotland. The success of local industries brought an influx of workers and their families to the area, resulting in an urgent need for housing, the solution being to use locally sourced clay, timber and reed thatch, a sustainable method of construction which is synonymous with the Carse of Gowrie.

Figure 5 The Old Schoolhouse, Cottown, Carse of Gowrie

The Old Schoolhouse is a single storey structure, approximately 13m x 7.5m in plan (Figure 5). The clay earth was built up in courses of approximately 600mm off a random rubble plinth and compacted by treading, rather than the adobe construction which may be found in warmer, drier climates. The addition of chopped straw to the clay adds to the tensile strength of the mixture. The external surface of the Old Schoolhouse is lime harl and limewash, following removal of unsuitable cement harl, offering some sacrificial protection to the mud wall construction. A timber roof truss supports the local River Tay reed thatching, while ceiling joists run through the wall construction to form the eaves. As a result of the building being vacant for a number of years conservation works in the 1990s included removal of harmful materials such as cement render, and replacement of timber roof members and thatch to reduce water penetration into the clay wall heads. The Old Schoolhouse was purchased by the National Trust for Scotland in 1993 following the Local Authority's issue of an Emergency Listed Building Repair Notice, having been vacant since 1985. Grant funding from the National Heritage Memorial Fund, Historic Scotland and Perth and Kinross Heritage Trust assisted the National Trust for Scotland in carrying out conservation works. Since the conservation works were completed environmental changes and neglect of adjacent Pows, a form of traditional land drainage, regular

seasonal flooding of the Schoolhouse site has resulted in the structure being threatened and in need of urgent repair. The Department of Architecture and Planning were approached by the National Trust for Scotland Little Houses Improvement Scheme to consider conceptual enablement strategies for the site through the provision of new housing. This offered the opportunity to investigate the local planning policies in relation to housing provision within Cottown as a whole and consider a development enablement strategy for the hamlet based on autarkic principles.

NEW HOUSING MODELS FOR AN AUTARKIC RURAL COMMUNITY IN COTTOWN, CARSE OF GOWRIE

Research Aims and Methodology

The aim of this research was to generate new spatial models of autarkic housing and alternative massing arrangements that responded to land-use, density, energy, landscape and current and future Scottish policy frameworks. The main objective in the study was to generate alternative, semi-quantifiable models that integrated the above requirements within holistic conceptual frameworks for rural sustainable living and which could then be used as a primer for further research and development. The methodology is based on previous work by RIBA/CABE in their study of future housing predictions 'Housing Futures 2024' (Worthington, 2004). Whilst there has been a distinct bias towards the qualitative in this endeavour, the research has been fundamentally a mixed methods approach with the design process forming a major part of the research method. It is both informed by quantitative data and provides the means by which data was generated for analysis. Design is an iterative process in which the implications of different decisions are weighed against each other in an informal evaluation process, until an optimum solution is arrived at. The criteria used in design development are typically both quantitative and qualitative in nature and the relative importance of each issue is often open to the personal bias of the designer. In light of this inherent subjectivity the designs were tested against specific quantifiable measures to give resistance to the decision making process, which included energy performance, density and floor areas. The scope of the research, developed in collaboration with industry stakeholders and specialist consultants, addresses the relationships between affordability, energy security, food cultivation, sustainable construction techniques, regional identity and spatial quality. The research was undertaken by the Macro Micro Studio, a Masters Research Unit within the department of Architecture and Planning at the University of Dundee along with MSc projects in Physics which investigated and supported the design-based research.

RESEARCH OUTCOMES

Energy Strategy

Figure 6 Fuel Poverty by urban-rural split and by gas grid coverage

The domestic sector accounts for nearly one third of all energy consumption, meaning it will have a significant role to play in reducing reliance on carbon-intensive generation while sustaining living standards and managing the protection of natural resources if climate change targets are to be met (Department for Energy and Climate Change, 2014, p5). The cost of living in rural Scotland is typically 10-40% higher than elsewhere in the UK, primarily due to the higher cost of food, clothes,

household goods, transport and fuel bills associated with the rural climate and fuel sources. Cumulatively these costs are not off-set by lower rural property prices (HIE, 2013, p4) (Figure 6). Fuel poverty is a historic problem in Scotland, the three primary drivers being energy efficiency, household income and energy prices, with the Scottish Government forming the definition that "A household is in fuel poverty if, in order to maintain a satisfactory heating regime, it would be required to spend more than 10% of its income (including Housing Benefit or Income Support for Mortgage Interest) on all household fuel use." (2015, p8). Over a third of the population was estimated to be living in fuel poverty in 2013, an increase of 12.9% since 2010, while fuel bills have risen six times faster than household incomes since 2003 (Scottish Government, 2015, p3, p9). The Government has set a target to ensure that people are not living in fuel poverty by November 2016 (Scottish Government, 2013b, p4). The vast majority of households in Scotland are reliant on fossil fuel-based traditional energy suppliers, and fuel poverty is exacerbated by suppliers' pricing structures being tied directly to fluctuations of the world energy market resulting in any increase being passed directly to the consumer (HIE, 2013, p4).

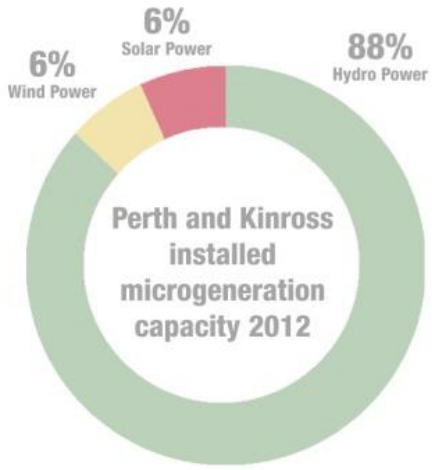

Figure 7 Renewable Energy Capacity in Perthshire

Figure 8 Reed harvesting, processing and biofuel production

Research into existing Scottish Government legislation regarding fuel poverty and micro generation identified a secure, renewable strategy for the Cottown proposals through establishment of a low energy community energy generation structure. Four methods of renewable micro generation were considered initially in the analysis: 50kw wind turbine; solar photovoltaic array; solar retrofit to existing properties; and combined heat and power (CHP) (Figures 7&8). Research identified a micro CHP plant using local reeds as a fuel source as the most appropriate low-carbon option in that it offered economic and social benefits in addition to efficient energy generation. The Tay Reed Bed is home to rare species of birds and insects, and requires cropping annually to sustain this fragile ecosystem. Each hectare of reeds can produce 5 tonnes of dried matter annually, which provides a potential energy content of 21MWh/t/Ha, making the potential for reeds as a fuel source for a CHP plant in conjunction with thermally efficient housing a viable proposition (Komulain, K., et al, 2008). Bailing the reeds, as opposed to transporting the reeds to England for compaction into pellets, would reduce carbon emissions, promote local employment and contribute further to the local economy. By sizing the CHP plant to meet the heat demand of the proposed housing, a surplus in electricity is generated which can be exported to the National Grid and could generate up to £12,000 per annum in Feed-In Tariffs. This sum could be used for community use, in employing a manager to run the CHP system, reducing bills, or reinvesting in community facilities.

The number of dwellings and their energy efficiency was determined to establish the total energy demand, and having confirmed housing density through contextual analysis of existing housing developments in the local area, the plot density of 40 dwellings per hectare was adopted as an economically viable model. Three standards of fabric efficiency were analysed: Code for Sustainable Homes Level 6 at 46 kWh/a m^2; Code for Sustainable Homes Level 6 + Mechanical Ventilation and Heat Recovery (MVHR) with airtightness to Passivhaus standard at 34 kWh/a $m^{2;}$ and Passivhaus at 15

kWh/a m^2, the results illustrating the potential number of developments supported being 9, 12 and 23 respectively (Figure 9).

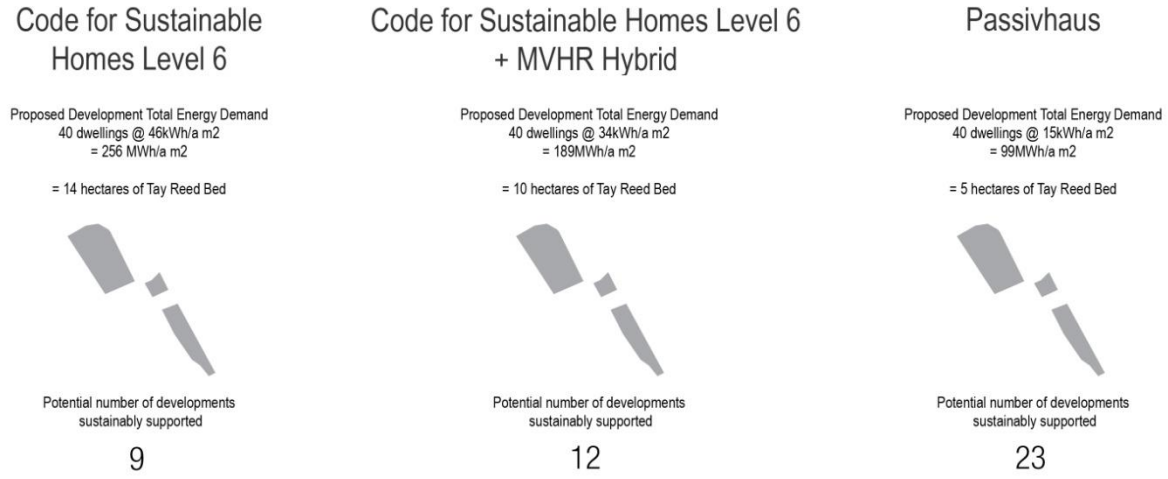

Figure 9 Analysis of fabric efficiency versus renewable energy demand

Density

Homes in the UK are the smallest, oldest and most expensive in Western Europe (Table 1). In Germany, which has a similar population density to the UK, the average new dwelling size is 109m2, compared with 76m2 in the UK. In the Netherlands, which has a higher population density than the UK, new dwellings are almost 50% larger. The UK has a high percentage of dwellings built before 1945 at 38.5% compared with 27.2% in Germany, and these older homes tend on average to be larger in area than new dwellings. Since the 1970s, house prices in the UK have risen faster than in any Western European country, Japan, Switzerland or the United States. Over this time period, house prices in the UK rose by around 3% while those in Germany remained stable. (Evans & Hartwich, 2005).

	Lowest area (m^2)	**Highest area (m^2)**
Parker Morris standards		
Apartment	44.2 (2p)	86.4 (6p)
House	74.3 (4p)	97.5 (6p)
Netherlands		
Vathorst	100	500
Ypenburg apartments	110	110
Ypenburg houses	140	180
Scotland		
Stephen Homes	79.7 (2 bed house)	145.8 (4 bed house)
Persimmon Homes	45.3 (1 bed apartment)	97.1 (4 bed house)
Scotframe	65.5 (2 bed house)	111.8 (4 bed house)
Barratt Homes	41.7 (1 bed apartment)	110.8 (4 bed house)
Stewart Milne	45.2 (1 bed house)	101.2 (4 bed house)

Table 1 Comparison of Parker Morris, Dutch Vinex and Scottish volume house builder gross floor areas (Adapted from Cousins, M., (2008))

An analytical study of six recent developments in the Carse of Gowrie by volume house-builders defined a specific attitude towards floor area and number of dwellings per hectare (*Figure 10)*. The current developer model is driven by the financial strategy of constructing on site to a density to provide a profit margin which varies by locality and market forces. The Perth & Kinross Local Development Plan defines low density housing as below 10 DPH (average 5), medium density housing as between 11-25 DPH (average 20), and high density housing as between 26-40 DPH

(average 35). The existing local developments studied are all detached or semi-detached properties, ranging from a minimum of 11 to a maximum of 21 DPH, therefore all falling into the Perth & Kinross Local Development Plan definition of average density.

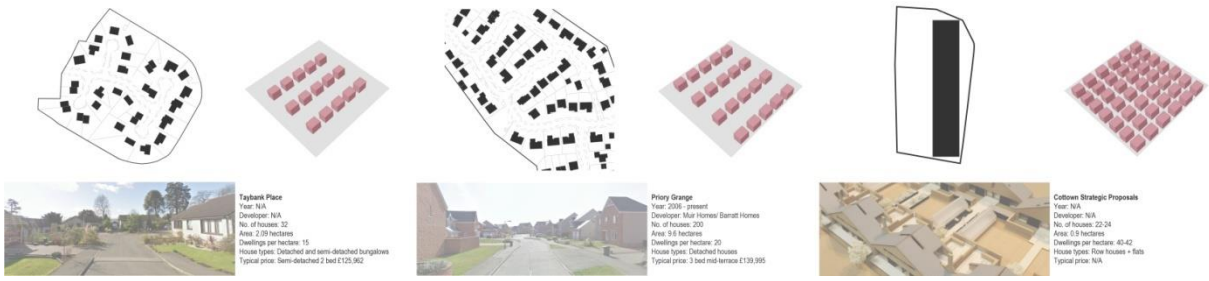

Figure 10 Examples of local density studies in comparison with the Cottown proposal

A density of 16 dwellings per hectare was established as an average developer density for the local area calculated from a survey of recent developments and when applied to the site returned a maximum number of units setting the benchmark for the sites economic viability. Published house plans were studied to calculate average dwelling floor areas and footprint sizes to ensure economic viability for the houses. The resulting floor areas used to inform design proposals were, for a 2 bedroom property 83m²; 3 bedroom property 96m²; and 4 bedroom property 107m².

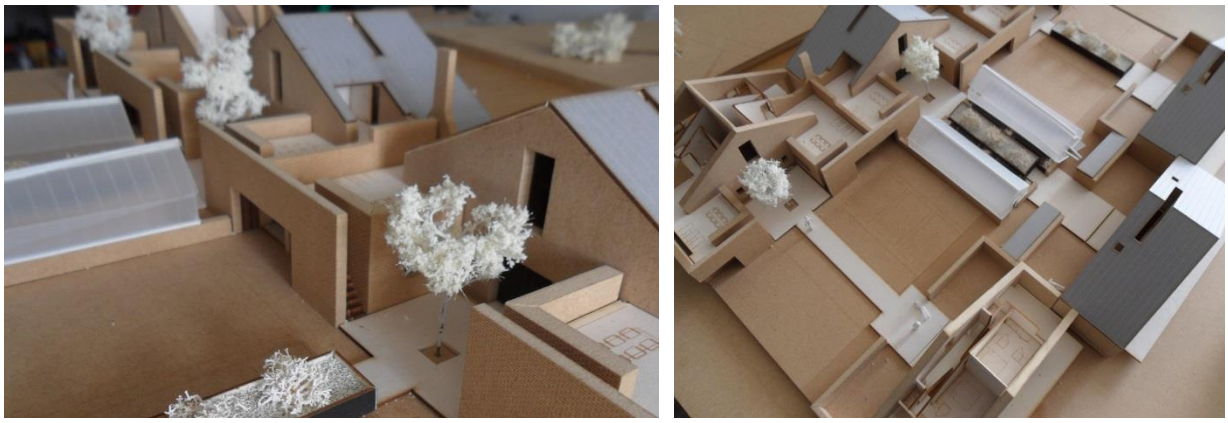

Figure 11, Example of an integrated practice-based research outcome from the study

Subsequently, a re-evaluation of the site keeping the total number of units constant but using an urban density of 40-42 dwellings per hectare facilitated a reduced development footprint which provided the opportunity to release land to be developed for other community purposes such as subsistent farming practices and shared community facilities. The strategic proposals investigated the possibility for like-minded individuals to lead housing procurement as a group, thereby directing funds into raising spatial design quality rather than forming the developer's profit and through shared facilities reduce the costs of essential services. Alternative procurement methods facilitated by Co-Housing and Baugruppe approaches were investigated which allowed the opportunity to re-evaluate the relationships between public and private realms, shared/community spaces and private gardens with all the proposed house types offering defined, private external space as well as access to shared areas. This approach inevitably led to considerations of how to resolve the massing, formal and spatial issues of developing to urban densities in a rural location of high aesthetic landscape value and creating an ‘identity’ for the development that responded to and intensified the intrinsic aesthetic relationships between built form and landscape particular to the Carse of Gowrie context (Figure 11).

Rural Types

Figure 12, Examples of regional rural typologies

Historically, rural building forms were largely influenced by immediately available materials, climate and specific use, resulting in regionally identifiable typologies (Figure 12). Maudlin noted that in Scotland traditional single storey dwellings with walls of mud or stone and roofs of thatch or turf were "integrated structures within the landscape" in that they were directly connected to the land through material, orientation and form (2009). More recently, however, characteristics of rural domestic buildings have lost specific regional distinctions due to the mono-cultural suburban residential model currently implemented by volume house-builders in Scottish rural areas. Unlike the regional characteristics apparent in traditional rural buildings, suburban development follows an essentially predefined development strategy irrespective of where it is implemented geographically. This type of development is having a detrimental impact on areas such as the historically significant Carse of Gowrie, where existing characteristics are at risk of being lost as housing development follows a generic architectural language.

As well as over 40 examples of mud wall construction in the Carse of Gowrie area, more recent typologies with specific rural characteristics include the range of buildings which characterise large country estates and farms. The farm typology is a hybrid of key buildings of different scale and hierarchy, with particular relationships to the form of the landscape in terms of topography and orientation. The detached farm house, steading clusters protecting working courtyards, walled gardens, row housing, agricultural barns and silos all retain particular architectural qualities representative of their location and use. Research and analysis of existing types in the Cottown area, specifically the agricultural barn, walled gardens and farm steading, was carried out to identify key characteristics and principles for use in generating place-specific proposals in response to generic volume house development. Taking inspiration from the regional sustainable building traditions exemplified by the existing mud wall and thatch Schoolhouse and the key characteristics of existing rural building types, the research led to three distinct scenarios for new housing models for an autarkic rural community in Cottown: Skinny Barn; Walled Garden; Urban Steading.

Skinny Barn

Figure 13, Skinny Barn: model, diagram and perspective

The Skinny Barn proposal investigates the typology of the regionally identifiable agricultural barn, allowing for higher housing density to be achieved while maintaining a recognisable rural language (Figure 13). The built form is located to the west of the site, releasing land for cultivation towards the east. A protected, car-free, courtyard forms a series of controlled spaces between the varied house

types, offering shared greenhouses, raised planters, seating, play areas, tool storage and main entrances to all houses. These pockets of external space relate to activities in the different house types forming the perimeter - the living spaces of the 3 and 4 bedroom types, and the shared facilities located at the entrances to the courtyard. Vehicular access is limited to the north and south edges of the development, with car parking located below maisonettes, maximising pedestrian ownership of the site. Pows, drainage ditches common to the area, define the built form in the landscape and separate public and semi-public areas. The land released to the east of the development site as a result of the higher density approach offers allotments and tool storage for use by the existing Cottown community as well as those living in the new development, connecting the existing and new communities.

The narrow plan of the 4 bedroom house offers visual and physical relationships from primary living spaces to both the shared courtyard and the Carse of Gowrie landscape. The houses are staggered in plan to allow privacy for the external deck cantilevered over the pow offering views across the Carse landscape to the west. Bedrooms are located on the upper level, accessed from the double height circulation space. The L-shaped plan of the 3 bedroom house locates kitchen and dining spaces towards the shared courtyard and living spaces towards the community allotment. Entrances are aligned with those of the 4 bedroom house types opposite, with all house types having entrances off the shared courtyard area. Shared facilities are located at the north and south entrances to the courtyard area, and include guest accommodation, meeting room, kitchen, laundry, workshop and multi-purpose space. Within the same built form, maisonettes propose ground floor bedrooms with views across the pow to the rural landscape, reeds offering a level of privacy. The upper floors offer living, kitchen and dining space with external balconies to the shared courtyard and rural landscape.

Walled Garden

Figure 14, Walled Garden: model, diagram and perspective

The Walled Garden proposal is directed by one of the characteristic elements of landed property in the Carse of Gowrie, forming a contemporary reinterpretation of the walled garden typology. Substantial country estates in the area included various forms of enclosed gardens for cultivation, social activities and education (Figure 14). As country estates have diversified and reduced in scale, new buildings have been located within walled gardens to accommodate a range of private or commercial uses while the perimeter wall remains a constant, recognisable element in the landscape. The proposal considers the potential for new-build formally planned communities based on the walled garden typology.

Individual houses are configured in a row to generate the perimeter wall, the collective mass forming a recognisable form in the landscape, enclosing and protecting a secluded space for subsistent living, community use and the reintroduction of the orchards which were historically prevalent in the Carse of Gowrie. The envelope formed by the row houses conceals the garden at the heart of the development, from which the natural horizon is only glimpsed at specific points. The enclosed garden becomes the primary focus, an external room of a different scale to the rural landscape. Vehicular access is limited to the external perimeter of the wall, with each house having an associated parking area on the bridge crossing the pow, adjacent to the main entrance. Pows running round the perimeter of the boundary wall emphasise the reading of the wall as an object in the rural landscape, giving the development identity and mass when viewed from a distance to correspond with existing rural forms.

Both 3 bedroom and 4 bedroom house types wrap living spaces around hard landscaped courtyards which mediate between the semi-public community garden and the privacy of the individual house, while bedrooms are located on the upper level with views across the rural landscape.

Urban Steading

Figure 15, Urban Steading: model, diagram and perspective

The Urban Steading proposal is driven by analysis of the farm steading form, a regionally identifiable typology which reflects the diversity of local farming types, building materials and construction methods as farms develop over time accommodating changing needs, offering a specific approach to community, density and identity in the rural landscape (Figure 15).

An analytical study of Design Codes led to development of strategic and detailed frameworks specific to the Carse of Gowrie in relation to community, density and identity. Influenced by Patrick Geddes's Valley Section, originally based on the River Tay and its regions, and Andres Duany's Urban-Rural transect, the strategic master plan was viewed as providing an overview for future development through consideration of the gradual transition from urban to rural as a mechanism for prevention of urban sprawl. At the detailed level specific steading characteristics were identified for interpretation into a language for contemporary housing, including the typical steading's U or O shape arrangement in plan, volumetric form, proportion and height, elevational relief, and material choice.

Three steading forms are arranged on the site with differing orientation, forming courtyards which respond to their context to offer protected areas for orchards and allotments. These semi-public areas, defined by the built form, promote subsistence living and shared activities to integrate existing and new communities. In addition to this, each dwelling has a private area of external space, its edges defined by the use of pows which reinstate the traditional form of drainage. The U-shaped plan form proposes two storey houses at ground level to east and west, and maisonette flats at first floor level forming a higher element to the north. Maisonette living spaces are located on first floor level accessed by an external terrace, with views both into the courtyard and out to the landscape. Bedrooms are located on second floor level, within the form of the roof, with views over the courtyard. Parking at ground floor level is situated to the rear of communal spaces which address the courtyard, and vehicular access to the site is restricted to two specific points to the north and south allowing pedestrian priority in the courtyards and routes between. For the four bedroom houses, the permeable ground floor addresses the shared courtyard area with large openings to living areas, while bedrooms are located within the roof form on the first floor with smaller, more controlled openings framing views to the rural landscape.

Conclusions

A review of European, UK and Scottish legislation has demonstrated the disconnect between planning, carbon abatement, energy efficiency and design quality policies at regional, local and applied scales. With the built environment contributing to 37% of carbon emissions, fuel poverty in rural Scotland reaching up to 40% in some areas and a net annual shortfall of 574 affordable houses in the Perth and Kinross area alone has resulted in an urgent need for more innovative solutions to the problem. The future sustainable, equitable, low-and zero-carbon communities that will be required to deliver this need alternative forms of housing of all tenures with mixed land uses and economies that are simply

not provided by the current mass-market housing mix. A deeper understanding at regional and individual levels of the underlying cultural, environmental and economic requirements of communities may generate more appropriate development frameworks and architectural responses to low-carbon rural living. Autarky principles that have emerged from central Europe recently potentially provide an answer to the rural housing conundrum in that low-carbon energy self-sufficiency can catalyse sustainable economic development providing resilience and the necessary economic means for inward investment in local community infrastructure whilst contributing to regional energy generation requirements through renewable energy exports. However, this will require a rewriting of policy and regulation at national and regional levels cross-cutting between planning, building regulations and procurement policy.

This study has applied these principles to a small development site at Cottown in the Carse of Gowrie, Perthshire where there is a growing demand for new housing. Using practice-based research methods a number of alternative spatial and physical models of sustainable low-carbon housing have been proposed. Skinny Barn, Urban Steading and Walled Garden are three spatially differentiated concepts integrating energy autarkic solutions, with higher density planning and new regional languages that respond to the unique high value landscape of the Carse of Gowrie.

Whilst the proposals take very different approaches, a number of common architectural issues have emerged from the study. Density and intensive use of land are needed to create clearly defined hierarchies and high quality external spaces. In all schemes, clustering of the built fabric allows very precisely controlled public spaces with clear boundaries and thresholds to be produced whilst achieving higher densities than suburban models. The perception of enclosure (and therefore density) is generated by the boundaries (walls, hedgerows and drainage pows). A more intensive use of land pockets relieves pressure on remaining land which can be released for alternative uses: green-space, wildlife corridors, swales, waterways, farming and allotments. An ordered landscape framework, based not on the primacy of the car, but on alternative land uses can achieve a scale of association with the existing rural landscape with built densities more in-keeping with the existing village. The primacy of the grid is used to deliver five main characteristics: order and regulatory, orientation in space and to elements, simplicity and ease of navigation, speed of layout, and adaptability to circumstance. An abstracted order does not replicate the organic formation of the village but seeks rules based on underlying factors more in keeping with contemporary requirements whether these are urban or rural. Identity and character can be achieved by the sensitive manipulation of the built fabric, material language and landscape form.

References

Abeg, B., 2011, Energy Self-sufficient Regions in the European Alps, Mountain Research and Development 31(4):367-371, International Mountain Society, Schaan

Burford, NK. & Pearson, AD., 2013, Ultra-low-energy perspectives for regional Scottish dwellings, Intelligent Buildings International, Vol. 5 Issue 4, Taylor and Francis, London.

CAG Consultants, 2014, Scottish Fuel Poverty definition - evidence review: Final Report, London

Cousins, M., 2009, Design Quality in New Housing: Learning from the Netherlands, Taylor and Frances, Oxon.

Department of Energy and Climate Change, Energy Consumption in the UK (2014), 2014, London

Dundee, Angus, Perth and North Fife Councils, 2012, TAYPlan, Strategic Development Plan 2012-2032

European Climate Foundation, 2010, Roadmap 2050: a practical guide to a prosperous low-carbon Europe: Volume 1 Technical and Economic Assessment, Brussels

European Parliament, Directive 2002/91/EC of the European Parliament on the energy performance of buildings, Brussels

European Parliament, (Accessed 2015), ROADMAP 2050, A practical guide to a prosperous, low-carbon Europe, www.Roadmap 2050.eu

Evans, A.W. & Hartwich, O.M., 2005a, Unaffordable Housing: Fables and Myths, Policy Exchange Limited, London, accessed 25.02.2015, http://www.policyexchange.org.uk/publications/category/item/unaffordable-housing-fables-and-myths?category_id=24

Evans, A.W. & Hartwich, O.M., 2005b, Bigger, Better, Faster, More: Why some countries plan better than others, Policy Exchange Limited, London, accessed 25.02.2015 http://www.policyexchange.org.uk/publications/category/item/bigger-better-faster-more-why-some-countries-plan-better-than-others?category_id=24

General Register Office for Scotland (GROS), 2010a, Population Projections 2008-2033: Scotland and Perth & Kinross, Edinburgh

General Register Office for Scotland (GROS), 2010b, 2008-based Household Projections: Scotland and Perth & Kinross, Edinburgh

GMB, 2013, 13.4% fall in earnings value during recession, accessed 25.02.2015, http://www.gmb.org.uk/newsroom/fall-in-earnings-value-during-recession

Goedman, Houtsma, and Zonneveld, 2008, Sustainability in Dutch Spatial Planning – Conf. Proc., 44th ISOCARP Congress.

Gulliver, S. and Tolson, S. (undated). Delivering Great Places to Live. [online]: University of Glasgow/RICS

Guzowski, M. 2010. Towards Zero Energy Architecture: New Solar Design. London: Laurence King Publishing Ltd.

Hayes, C. W., 2007, Historic Orchards of the Carse of Gowrie: Phase 1 Survey - An Investigative Study on their Location, Extent and Condition for the Perth & Kinross Countryside Trust, Fife, accessed 25.02.2015, www.crispinwhayes.com/projects.html

Highlands and Islands Enterprise, 2013, A Minimum Income Standard for Remote Rural Scotland, Inverness: HIE Enterprise

Koek, R., Maas, W., & Van Rijs, J.,1998, FARMAX: Excursions on Density, MVRDV and 010 publishers, Rotterdam.

Komulain, K., Simi, P., Hagelberg, E., Ikonen, I., Lyytinen, S., 2008, Reed Energy: Possibilities of using the Common Reed for energy generation in Southern Finland, Turku University of Applied Sciences, Finland

Maudlin, D., 2009, The Highland House Transformed: Architecture and Identity on the Edge of Britain: 1700-1850, Edinburgh University Press

Mellor, H., 1990, Patrick Geddes: Social Evolutionist and City Planner, Routledge, USA.

Office for National Statistics, 2013, Annual Survey of Hours and Earnings (ASHE) Provisional Results,

Owens, EH., Peacock, A., Roaf, S., Corne, D., Dissanayake, M., Galloway, S., Stephens, B., Tuohy, P., 2014 Autarkic Energy Systems: Balancing Supply And Demand with Energy Storage and Controls in Local Energy Micro-grids. / Conf. Proc., 2014 Asia-Pacific Solar Research Conference, Sydney.

Pearson, AD, 2014, An investigation of Climatically Responsive Ultra-Low Energy Housing in Rural Scotland: A Case Study, PhD Thesis, University of Dundee.

Perth & Kinross Council, 2012, Affordable Housing Supplementary Guidance (AHSG), Perth

Perth & Kinross Council Local Development Plan, 2014, Perth

The Scottish Government (2001). Designing Places. Edinburgh

The Scottish Government, 2003 ASP 8, Building (Scotland) Act 2003, Edinburgh

The Scottish Government, S. A. H. 2008. A Low Carbon Building Standards Strategy for Scotland (The Sullivan Report). Accessed September 13, 2010. http://www.scotland.gov.uk/Topics/Built-Environment/ Building/Building-standards/publications/sullivan

The Scottish Government, 2009 ASP 12, Climate Change (Scotland) Act 2009, Edinburgh

The Scottish Government (2010a). Designing Streets. Edinburgh: RR Donnelley

The Scottish Government (2010b). Delivering Better Places. Edinburgh: APS Group

The Scottish Government, 2012, Rural Scotland Key Facts, Edinburgh: APS Group

The Scottish Government, 2013, Building Standards Technical Handbook (Scottish Government 2013c), Edinburgh

The Scottish Government (2013). Creating Places. Edinburgh: APS Group

The Scottish Government, 2013b, Scotland's Sustainable Housing Strategy, Edinburgh: APS Group

The Scottish Government, 2013c, Scottish House Conditions Survey 2012, Edinburgh: APS Group

The Scottish Government (2014a). National Policy Framework 3. Edinburgh: APS Group

The Scottish Government (2014b). Scottish Planning Policy. Edinburgh: APS Group

The Scottish Government, 2015, Progress Report of the Scottish Fuel Poverty Statement 2002, Edinburgh: APS Group

Skerratt, S., Atterton, J., Hall, C., McCracken, D., Renwick, A., Revoredo-Giha, C., Steinerowski, A., Thomson, S., Woolvin, M., Farrington, J, and Heesen, F., 2012, Rural Scotland in Focus 2012, Edinburgh: Rural Policy Centre, Scottish Agricultural College

Thomas, R., & Garnham, T., (2007, The Environments of Architecture, Taylor and Francis, Oxon.

UK Department for Communities and Local Government, 2008, Code for Sustainable Homes, RIBA Publishing, London

Vale, B., & Vale, R., 2000, The New Autonomous House, Thames and Hudson, London

Worthington, J. (2004). Housing Futures 2024: A Provocative Look at Future Trends in Housing, Building Futures, CABE / RIBA, London, England.

Zammer, J., 2005, Voralberg, Austria: the Land of a New Alternative Development, Conf. Proc., PLEA2005, The 22nd Conference on Passive and Low Energy Architecture, Beirut